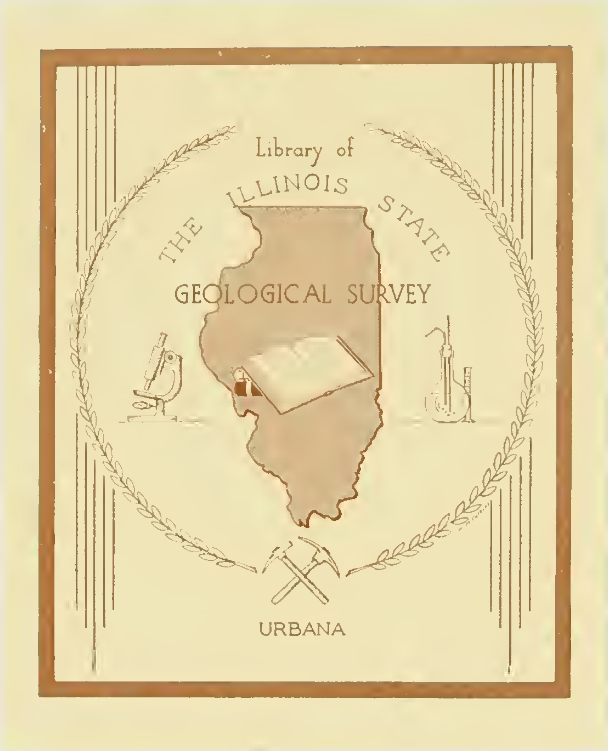

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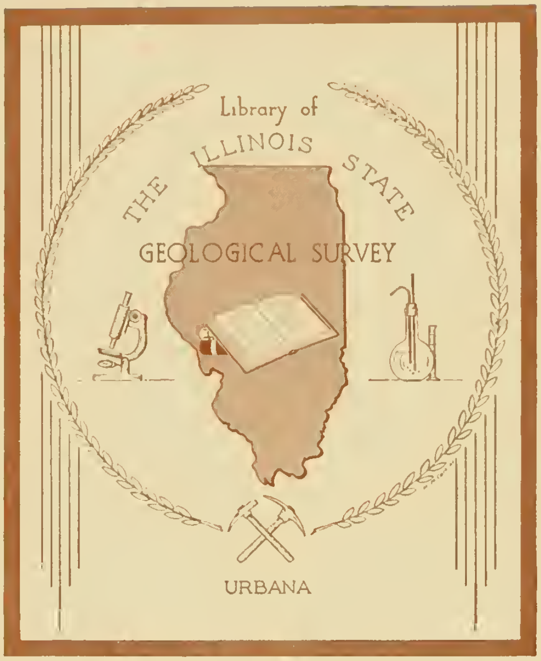
# CONTROLLED DRILLING PROGRAM IN NORTHEASTERN ILLINOIS

*JAMES E. HACKETT*
*GEORGE M. HUGHES*

ILLINOIS STATE GEOLOGICAL SURVEY
*JOHN C. FRYE, Chief · Urbana*



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# FOREWORD

"Environmental Geology Notes" is a new series of information releases published by the Illinois State Geological Survey to report applications of geologic knowledge to problems of the human environment. Geologic information is applicable to a broad range of activities, including construction of buildings and transportation facilities, installation of utility facilities, safe disposal of waste products, development and management of water and mineral resources, and planning for the most efficient and beneficial use of the land.

"Environmental Geology Notes" are designed to inform engineers, professional planners, municipal, county, and state officials, and other interested individuals about current work of the Geological Survey in their fields, and to provide them with specific data and descriptive materials that otherwise would be available only in the Survey files.

To serve such a varied audience, reports on many different subjects will be included in this series. The first issue describes a subsurface drilling program that was conducted as a part of an extensive study of water resources in the six counties of the metropolitan area of northeastern Illinois. Subsequent reports will provide the data obtained from individual borings in each of these counties. Other reports planned for early release will include a discussion of the geologic aspects of sanitary landfills and descriptions of special geologic features of northeastern Illinois that have a relation to areal development.

# CONTROLLED DRILLING PROGRAM
# IN NORTHEASTERN ILLINOIS

James E. Hackett and George M. Hughes

## INTRODUCTION

Fifty-two borings were made to obtain subsurface data and samples of unconsolidated materials, mainly glacial drift deposits, in the six-county metropolitan area of northeastern Illinois during the spring and fall of 1963. The work was part of a study on water-resources management coordinated by the Northeastern Illinois Metropolitan Area Planning Commission. The study was financed in part by a planning grant made available from the Federal Home and Housing Finance Agency. The drilling and sampling program was supervised by the Illinois State Geological Survey and supplemented the Survey's collection of data on the thickness and distribution of the glacial drift materials. The drilling was contracted to the Layne-Western Company of Aurora, Illinois.

Specific aims of the drilling program were as follows:

1. To supplement the existing information about the subsurface geology of the area so that the distribution of sand and gravel aquifers could be mapped.
2. To aid in evaluating and correlating less reliable subsurface data from other sources, such as water well records.
3. To obtain subsurface control in areas where data from other sources were not available and where such data were critically needed—for instance, in the vicinity of the major bedrock valleys.
4. To obtain samples from which laboratory analyses of the physical properties, such as grain-size distribution, of the major glacial drift units could be made.
5. To obtain shot holes for use in geophysical studies.

Approximate locations for drill holes were selected by the Illinois Geological Survey in localities that would best satisfy those purposes. Each boring was assigned a number and its location plotted on a small map of the area. This map, a log of the thickness and character of the glacial drift materials anticipated at the site, and a note on the purpose of each boring were forwarded to the drilling contractor. Minor modifications in the order and location of drilling were made by the contractor to provide the most efficient rig operations. The drilling contractor recorded moisture content, strength measurements, number of blows needed to drive the sampling tool 1 foot, and materials penetrated. Grain-size analyses and density measurements were determined in the laboratory of the Illinois Geological Survey.

## DRILLING EQUIPMENT AND METHODS

Equipment used by the Layne-Western Company consisted of two Mobile drilling rigs (models B52 and B61) with 2 3/4 I.D. hollow-stem augers, and two Franks rotary rigs (models KC45 and FA54) that used water or drilling mud as necessary. A driller, a driller's helper, and a sampler (a graduate geologist) composed the rig crew. Later in the program, the Franks KC45 rig was modified by the addition of a platform and rack on the tower. By racking the drill pipe vertically instead of tailing it on the ground, samples could be procured from the required depths in a much shorter time.

Samples were obtained with the Mobile drilling rigs by using 2-inch or 2½-inch split-tube samplers (ASTM D-1586) below the augers. The tube was attached to drilling rods, lowered inside the hollow augers and driven 18 inches, rather than the standard 12 inches, by a 140-pound hammer that had a free fall of 30 inches. The Franks rotary rigs used the same types of split-tube samplers, which were driven 18 inches by a 475-pound stem and jar that fell 36 inches on a wire line.

It was originally hoped that after a Mobile drilling rig had drilled the upper 100 feet of each hole a Franks rig could continue drilling the same hole to bedrock. However, it was found to be more efficient to begin a new hole with a Franks rig rather than set it up in the augered hole. Later in the program a Mobile drilling rig was used for all holes that were expected to be less than 125 feet deep, and a Franks rig was used for the deeper holes.

In the early part of the program, split-tube samples were taken at 2½-foot intervals to 100 feet, at 5-foot intervals from 100 to 300 feet, and alternate wash and split-tube samples at 5-foot intervals below 300 feet. Split-tube samples also were taken at each major lithologic change, and wash samples were taken where split-tube recoveries were poor. To save time, this procedure was later modified, and the 2½-foot split-tube samples were taken only through the weathered zone.

Satisfactory split-tube samples were obtained with the Franks KC45 rig from deposits as much as 470 feet deep.

## TESTS PERFORMED BY THE CONTRACTOR AND INFORMATION PROVIDED

Unconfined, compressive ~~comprehensive~~ strength measurements of cohesive materials were made at the rig immediately after the split-tube sample was obtained. Under normal circumstances, these measurements were made on a Rimac spring tester and converted to tons per square foot; but when the samples were badly disturbed, or severe freezing conditions made it difficult to use the spring tester, strength was measured with a pocket penetrometer.

In the experience of the contractor, unconfined compressive strength values exceeding 2 tons per square foot obtained by the Rimac spring tester correlate well with those obtained with controlled rate of strain methods. For values of less than 2 tons per square foot, the Rimac spring tester is not as accurate.

A small part of each split-tube sample was sealed in a can and the natural moisture content for the cohesive samples was determined in the laboratory and given as percentage of dry weight.

Material descriptions followed the contractor's Soil Classification Chart. The blow-count measurements made with the Franks rotary rigs cannot, as yet, be related to measurements obtained in a standard penetration test, but results seem to be consistent.

## TESTS PERFORMED BY THE ILLINOIS STATE GEOLOGICAL SURVEY

Grain-size distribution and density data were determined at the Illinois Geological Survey laboratories in Urbana, where the remainder of the split-tube samples and the wash samples had been sent in plastic bags. The procedures used for analysis of both the cohesive and noncohesive materials follow.

### Cohesive Materials

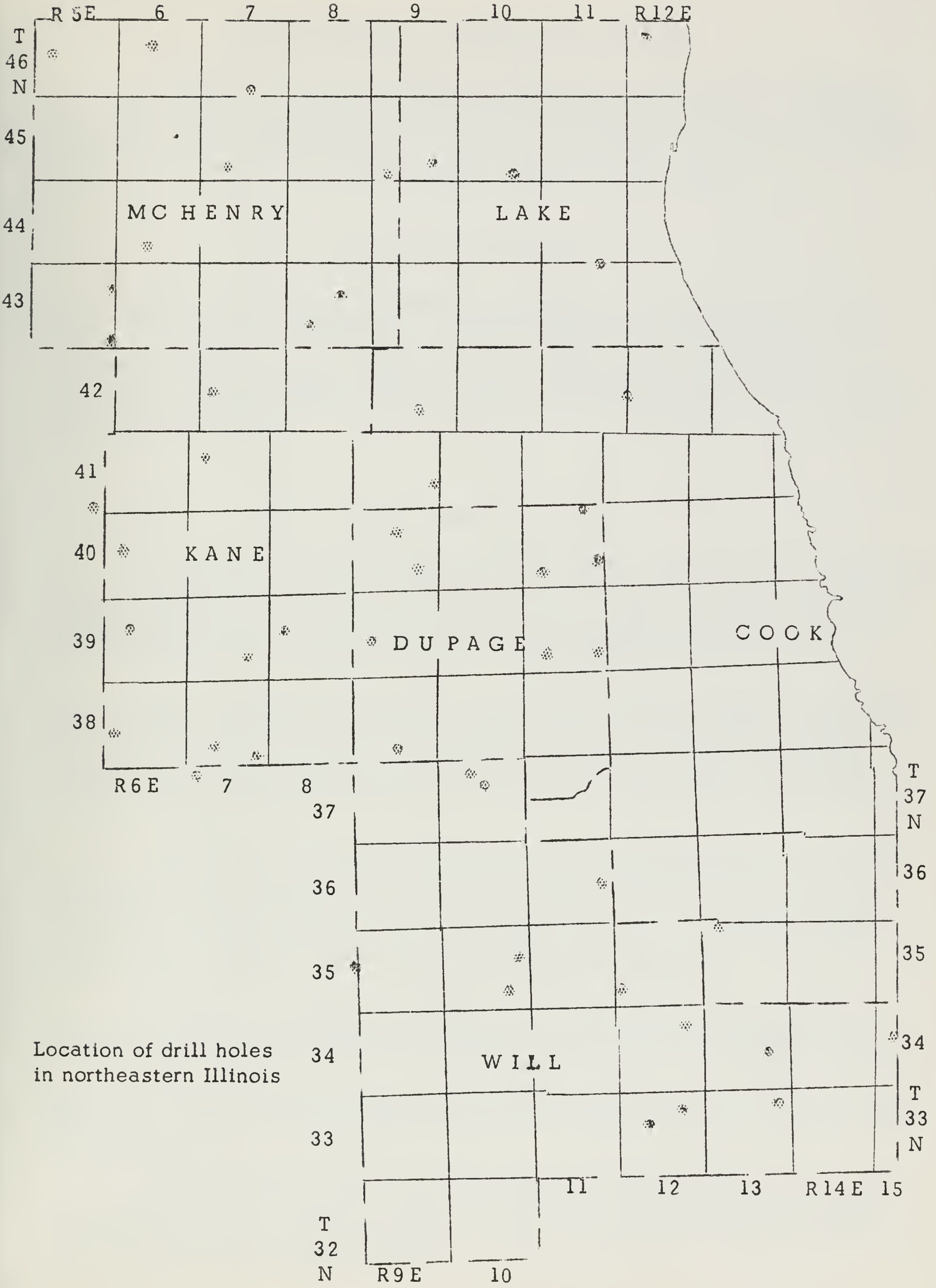
Hydrometer analyses were used to determine the amount of clay (particle diameter 0.0039 mm) in each sample. Samples of approximately 55 grams were taken, and both temperature and deflocculant corrections were made. The amount of material coarser than silt (diameter greater than 0.0625 mm) was determined by sieving, and the amount of silt was determined by subtracting from the weight of the total sample the weight of the coarser material plus the weight of the clay.

Density determinations of 130 samples were made by the Geophysical Section of the Survey to help calculate the Bouger corrections for a gravity survey of the region. For these determinations, the sample was removed from the plastic bag and, without further preparation, was weighed in air and its displacement in water measured.

Results for samples in which 68 percent by weight of the particles are less than 0.062 mm in diameter are believed to be accurate within 0.1± gm/cc. As the main error is believed to have resulted from water loss from the samples by gravity drainage, the density values obtained are lower than true values (McGinnis et al., 1963, "Relationship of Gravity Anomalies to a Drift-Filled Bedrock Valley System in Northern Illinois," Illinois Geological Survey Circ. 354). For materials in which more than 68 percent by weight of the particles are coarser than 0.062 mm in diameter, the error in density measurements made by this method is likely to be significantly larger.

### Noncohesive Materials

The noncohesive samples were passed through a nest of 10 Tyler sieves. The sieve analyses, their U. S. Standard equivalents, the diameter of the mesh openings in inches and millimeters, and the Wentworth grain-size classification, were compiled in tabular form. Samples containing fine-grained aggregates were washed and the resulting weight loss was included in the "pan" fraction.



Location of drill holes in northeastern Illinois

## TESTS PERFORMED BY ISOTOPES, INCORPORATED

In several of the organic zones penetrated, fragments of peat and wood were found. These were collected and sent to Isotopes, Inc., Westwood, New Jersey, where their radioactive carbon-14 content was measured to determine their age. The results of these tests made it possible to assign ages to the glacial drift units in which the organic materials were found.

## LOCATION OF THE BORINGS

The accompanying map shows the location of the 52 holes drilled. They are, with a few exceptions, distributed quite evenly throughout northeastern Illinois. As the selection of the individual drilling sites was determined by the purposes listed earlier, it was found necessary to choose more sites in some counties, such as Will and McHenry, than in others. On the other hand, in the highly urbanized areas, much of Cook County for instance, drilling was avoided.

## APPLICATIONS OF THE DRILLING DATA

The data accumulated contributed much basic hydrogeologic information that aided the study of the geologic phases of the water-resource management program. Analysis of all these supplementary data led to better recognition and understanding of the character and distribution of the glacial drift units and helped to establish relations between adjacent units.

The information obtained by the drilling program, used in conjunction with existing subsurface information, made possible more accurate mapping of the sand and gravel aquifers of northeastern Illinois. As all 52 borings penetrated the entire glacial drift sequence and terminated at the bedrock surface, they facilitated mapping the elevation of this surface for the water-resource management study.

Quantitative data on the character of both fine-grained and coarse-grained glacial drift added considerable geologic information that could be used for the determination of ground-water recharge rates to glacial drift and shallow dolomite aquifers in the metropolitan area. The Illinois State Water Survey provided the basic hydrologic data and evaluated the potential yield of these shallow aquifers from this geologic information.

The data on physical properties of the materials drilled assisted in further defining stratigraphic relations, and these data will form part of the basis for continuing studies of the drift units by the Geological Survey.

The radiocarbon dating of buried peat and wood found in some of the bore ~~base~~ holes will be of considerable aid in determining the age relations of the glacial deposits.

The descriptive logs for each of the 52 borings, as well as the laboratory analyses of all of the samples collected, will be presented in forthcoming issues of this series. The next report, Environmental Geology Notes 2, will give the data for DuPage County.